

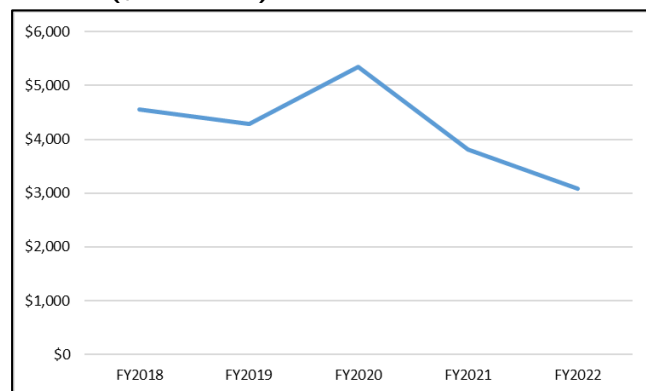
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## Defense Primer: U.S. Precision-Guided Munitions

The Department of Defense (DOD) defines a precision-guided munition (PGM) as a “guided weapon intended to destroy a point target and minimize collateral damage.” This includes air- and ship-launched missiles, multiple launched rockets, and guided bombs. PGMs typically use the global positioning system (GPS), laser guidance, or inertial navigation systems to improve a weapon’s accuracy to reportedly less than 3 meters (approximately 10 feet).

Recent operations have heavily relied on PGMs for counter-insurgency operations. The recent National Defense Strategy articulates a renewed focus on great power competition to combat anti-access/area denial (A2/AD) systems. The wide proliferation of A2/AD is likely to increase the operational utility of PGMs. In particular, peer competitors like China and Russia have developed sophisticated air defenses and anti-ship missiles that increase the risk to U.S. forces entering and operating in these regions. As a result, DOD has argued it requires longer-range precision munitions to meet these new threats.

**Figure 1. U.S. Military Spending on PGMs FY2018-FY2022 (\$ in millions)**



**Source:** Department of Defense Budget FY2019-2022 P-1 Procurement budget requests, at <https://comptroller.defense.gov/Budget-Materials/>.

The U.S. military has become reliant on PGMs to execute military operations (**Figure 1**), being used in ground, air, and naval operations. Over the past five years, DOD

- in FY2018, procured 68,800 munitions for \$4.6 billion;
- in FY2019, procured 60,600 munitions \$4.3 billion;
- in FY2020, procured 55,200 munitions \$5.3 billion;
- in FY2021, appropriated \$3.8 billion for 39,500 munitions; and
- in FY2022, requested \$3.1 billion 16,700 munitions.

### Air-Launched Precision Munitions

- **Paveway Laser Guided Bomb.** The Paveway is a family of guidance kits that attach to unguided bombs. The assembly includes a seeker on the nose of the bomb

that looks for a laser to mark a target and a tail kit to steer the bomb. The Paveway series was originally developed during the Vietnam War to enable tactical aircraft—like the F-4 Phantom—to deliver precise munitions. Paveway has received many upgrades over the decades, most recently the Paveway III (developed in the 1990s), which improves low-altitude guidance.

- **Joint Direct Attack Munition (JDAM).** JDAM is a tail kit that modifies unguided bombs—the 5,000 pound Mk-82, 1,000 pound Mk-83, and 2,000 pound Mk-84 bombs—with GPS guidance (see **Figure 2**). When a JDAM kit is attached, the weapon is designated a guided bomb unit (GBU -31/32/38 depending on the weight of the bomb). JDAM has a reported range of 13 nautical miles. The first operational use of a JDAM was during Operation Allied Freedom in Kosovo by a B-2 Spirit bomber. JDAMs are used by all fixed-wing strike aircraft.

**Figure 2. GBU-31 Joint Direct Attack Munition**



**Source:** <https://militaryedge.org/armaments/gbu-31cv1-jdam/>.

- **Hellfire Missile.** The first Hellfire was introduced into service in 1982 on the Army’s AH-64 Apache, using laser guidance to target tanks, bunkers, and structures. Hellfire missiles have a maximum effective range of 4.3 nautical miles. During the late 1990s and early 2000s, Hellfire missiles were introduced on the MQ-1 Predator, and later the MQ-9 Reaper, enabling unmanned aerial vehicles to provide a strike capability. Hellfire missiles have become a preferred munition for operations in the Middle East, particularly with increased utilization of unmanned aircraft like MQ-1s and MQ-9s.
- **Joint Air-to-Ground Missile (JAGM).** The Joint Air-to-Ground Missile is designed to replace the Hellfire, TOW, and Maverick missiles. JAGM uses a new warhead/seeker paired with an existing AGM-114R rocket motor to provide improved target acquisition and discrimination. JAGM underwent testing starting in 2010, declaring initial operating capability in 2019 having successfully been integrated on the AH-64E Apache and AH-1Z Super Cobra attack helicopters.
- **Joint Air-to-Surface Standoff Missile (JASSM).** The JASSM is a 14-foot-long, 2,250-pound missile that can

be carried internally on B-1B Lancer and B-52 Stratofortress aircraft, and externally on a number of tactical fighters, including the F-16 Falcon, F-15E Strike Eagle, F/A-18 Hornet (see **Figure 3**), F/A-18E/F Super Hornet, and F-35 Lightning II. In 2004, the Air Force developed an extended range version of the JASSM. The JASSM-ER uses the same body as the previous version, adding an improved infrared seeker, a two-way datalink, and enhanced anti-jam GPS receiver.

**Figure 3. JASSM Attached to an F/A-18D Hornet**



**Source:** [https://commons.wikimedia.org/wiki/File:F-18D\\_Hornet\\_\(HN-466\)Tour\\_de\\_Sky\\_2014-08-09\\_06\\_JDAM\\_AGM-154.JPG](https://commons.wikimedia.org/wiki/File:F-18D_Hornet_(HN-466)Tour_de_Sky_2014-08-09_06_JDAM_AGM-154.JPG).

- **Long Range Anti-Ship Missile (LRASM).** LRASM was conceived by the Defense Advanced Research Projects Agency, using a JASSM missile body to replace the AGM-88 Harpoon. Flight testing began in 2012 with the B-1B and the F/A-18E/F Super Hornet. LRASM uses radio-frequency sensors and electro-optical/infrared seekers for guidance.

## Ground-Launched Precision Munitions

- **Army Tactical Missile System (ATACMS).** ATACMS is a 610-millimeter rocket that can be launched from either the M270 MLRS (two rockets) or the M142 High Mobility Artillery Rocket System (HIMARS) (one rocket) (see **Figure 4**). ATACMS was developed in the 1980s and later updated to use GPS guidance. In 2016, then-Secretary of Defense Ash Carter announced that the Strategic Capabilities Office had developed a new seeker for the ATACMS to target ships, enabling multidomain operations.

- **Figure 5** is an anti-ship low observable cruise missile capable of flying close the surface of the ocean to avoid radar detection. The NSM is designed to fly multiple flight profiles—different altitudes and speeds—with effective ranges of between 100 and 300 nautical miles at a cruise speed of up to 0.9 Mach. The Navy has integrated the NSM on its Littoral Combat Ship, which deployed to the Pacific region in September 2019.

**Figure 4. ATACMS Launching**



**Source:** <https://www.lockheedmartin.com/content/dam/lockheed-martin/mfc/pc/army-tacticle-missile-system-block-ia-unitary-atacms/mfc-atacms-block-ia-unitary-pc.pdf>.

- **Guided Multiple Rocket Launch System (GMLRS).** GMLRS is a GPS-guided, 227-millimeter rocket that was developed in 1999 and entered service in 2003. It is capable of being launched from the M270 multiple launch rocket system (MLRS) and the M142 HIMARS.
- **Precision Strike Missile (PrSM).** The PrSM is a new development program intended to replace ATACMS. PrSM can launch from the M270 and HIMARS. The Army states that PrSM is designed to be able to launch two missiles in a launcher pod compared to ATACMS's single missile, have a range in excess of 400 kilometers, and have an anti-jam GPS antenna. The Army plans to have the PrSM enter operational service in FY2023.

## Naval Precision Munitions

- **Tomahawk Cruise Missile.** The Tomahawk was developed during the early - to mid-1970s. It is launched from submarines and from surface combatants. Tomahawk has a reported range of 870 NM at speeds of Mach 0.85, and uses GPS and inertial navigation system. The Tomahawk Block IV is the latest variant.
- **Standard Missile-6 (SM-6).** The Standard Missile-6 was originally designed as an anti-aircraft missile, derived from the Navy's SM-2 Block IV in 2004. Since its development, the SM-6 has been integrated into the Navy's Naval Integrated Fires-Counter Air (NIF-CA) program to strike enemy surface ships. The missile was designed to receive targeting information from AEGIS radars and the E-2D Advanced Hawkeye in flight.

**Naval Strike Missile (NSM).** The NSM (see

**Figure 5. NSM at Launch**

**Source:** <https://www.naval-technology.com/news/us-navys-gabrielle-giffords-lcs-launches-naval-strike-missile/>.

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**CRS Products**

CRS Report R45996, Precision-Guided Munitions: Background and Issues for Congress, by John R. Hoehn.

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